LATERAL CONTINUITY OF MINERALOGICAL AND MORPHOLOGICAL CONTACTS AROUND MT. SHARP: LINKING UPCOMING ROVER OBSERVATIONS AND ORBITAL DATA. R. Y. Sheppard[1*], R. E. Milliken[1], Y. Itoh[2], and M. Parente[2]. [1]Dept. Earth, Environmental, and Planetary Sciences, Brown University, [2]Dept. Electrical and Computer Engineering, University of Massachusetts, Amherst. *rachel_sheppard@brown.edu

Introduction: Mt. Sharp in Gale crater is a ~5 km thick stratigraphic section, the lower portion of which includes a >200 m thick sequence of mudstones deposited in a lacustrine environment [1] that have been explored by the Curiosity rover. One of the most prominent features observed from orbit in Mt. Sharp is a dark section of strata (Fig. 1) previously mapped by [2] as the middle member of the lower formation of the Mt. Sharp group. This zone is underlain and superposed by lighter-toned strata. We use newly processed visible-near infrared CRISM spectral data to examine the mineralogy of these zones and the transitions between them in greater detail, with the goal of providing insight into whether these transititions are most consistent with diagenetic or primary depositional processes. Importantly, we demonstate that the tonal and mineralogical changes across these boundaries appear to be present throughout Mt. Sharp, thus they are likely to be traversed by the Curiosity rover in the future.

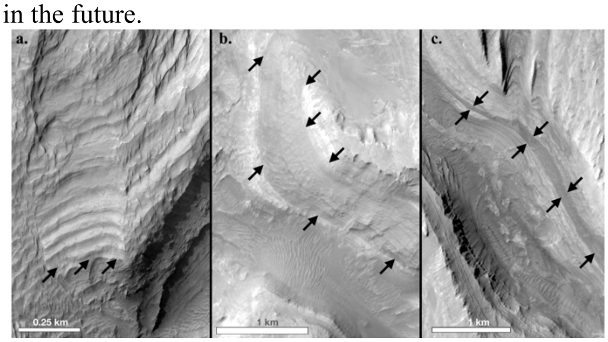

Fig. 1: *Examples of the morphology of the dark band and its two contacts into lighter-toned bands above and below. (**a.**) Southern, (**b.**) southwestern, and (**c.**) Grand Canyon/western Mt. Sharp.*

Methods: Stratigraphic variations in mineralogy are assessed using nine CRISM images processed using a modified version of the novel technique, corrupted linear spectral mixing model (CLMM), which reduces the effects of instrument noise and atmosphere [3,4]. Mineralogical mapping is performed using CRISM spectral parameters [5], and mineral detections are verified by manual inspection of numerous individual pixels. Geomorphic mapping based on HiRISE and CTX images is conducted independently from spectral analyses and all data are integrated into a GIS framework. The previously defined "marker bed" of [2] is used as a stratigraphic baseline to determine relative stratigraphic positions of different mineralogical signatures.

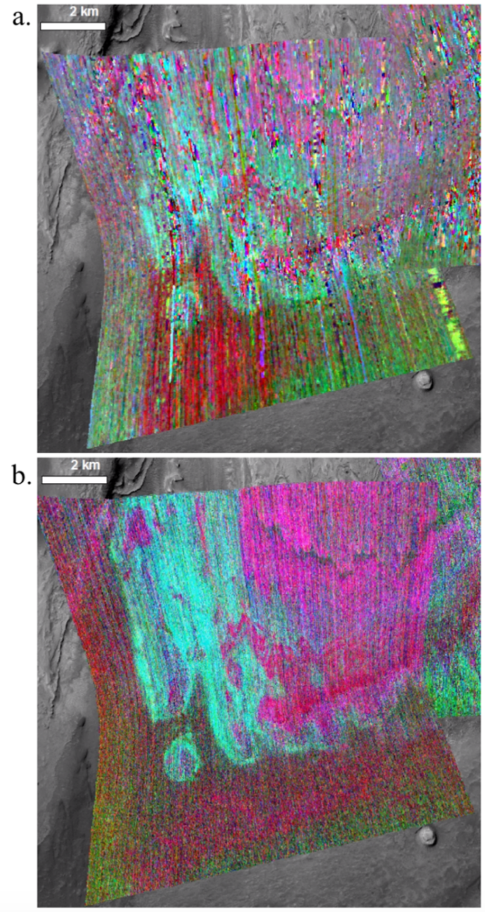

Fig. 2: *Comparison of CRISM spectral parameter maps from southeastern Mt. Sharp (**a.**) before and (**b.**) after processing. Red = BD1900, green = BD2100, blue = SINDEX [5].*

Results and discussion: Our spectral analyses of the newly processed CRISM data show significant improvement in noise reduction and spatial coherence of mineral detections (Fig. 2). Previous CRISM-based mineralogical analyses across Mt. Sharp demonstrated the presence of clays and sulfates in select locations but relied on spectral ratio methods [e.g., 6], which can be subject to error or accidentally remove spectral features of interest. The new CRISM products reveal clear mineral absorption features in the resulting reflectance spectra, thus minimizing the need for spectral ratios and confirming that these features are not an artifact of the ratio process. These data provide a clearer and more reliable portrayal of the spatial distribution of minerals throughout Mt. Sharp.

We find that the light-to-dark-to-light morphological contacts correspond to the same mineralogical changes around the mound, suggesting that these are through-going compositional transitions. The dark band itself is enriched in kieserite; the layer below the dark band contains polyhydrated sulfate and patchy occurrences of clay that vary laterally around the mound; the strata above the dark band are spectrally relatively pure polyhydrated sulfate (Figs. 3-4). Strong Fe-Mg clay signatures (Fig. 4b) are found around the mound in relative stratigraphic positions analogous to the "clay unit" that will be explored by Curiosity [7] but are also exposed above and below those strata.

Implications and Conclusions: A primary motivation for selecting Gale crater as a landing site was the orbital observation of discrete mineralogical changes with stratigraphic height [2,6,8]. We identify that the light-dark-light transition observed around Mt. Sharp corresponds to the same mineralogical transitions in each case, suggesting that this is a coherent package of strata that is enriched in sulfates with lesser clay that exists through the entire mound. Information on the distribution, chemistry, and hydration state of sulfates in the mound can help constrain the past conditions of this environment, including during deposition within Lake Gale and post-depositional diagenetic processes. For example, it is possible that the observed mineralogical transition formed primarily during lacustrine deposition as the lake became increasingly saline, with patchy clay layers in the lower light-toned zone representing lateral variability in conditions during this dynamic time. Another option is that the sulfates could represent primary precipitates that formed after the canonical "drying out" of the martian environment, representing post-lacustrine episodes of aqueous activity (e.g., playa-like environments) at the planet's surface. Alternately, the sulfate minerals could represent an entirely diagenetic signature suggestive of groundwater infiltration, possibly into porous sandstones, with lateral variation recording the pathways of diagenetic fluids. The generally through-going nature of these mineralogical zones and their associated morphologies suggests that whatever process created them occurred throughout Mt. Sharp. This suggests that at least some processes documented along the rover traverse are applicable to the crater environment as a whole.

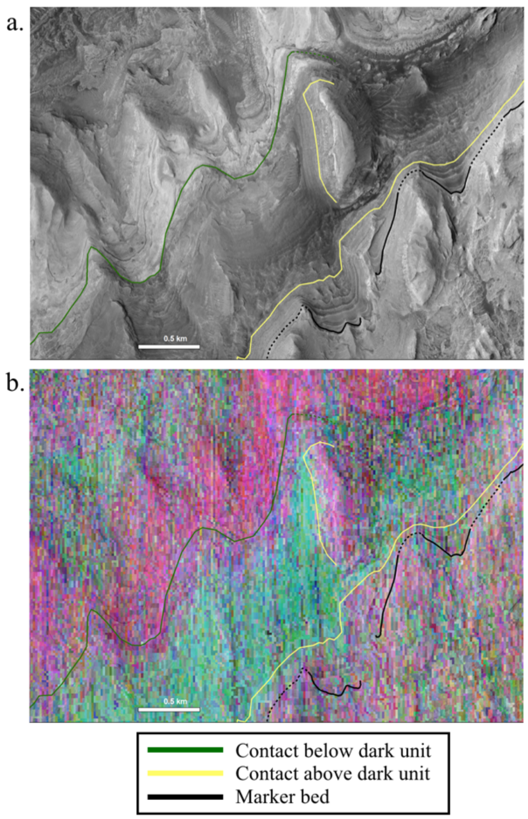

Fig. 3: *Detail of an area in northwestern Mt. Sharp highlighting the dark band* ***(a.)*** *with boundaries traced based on HiRISE morphology alone and* ***(b.)*** *with the CLMM-processed CRISM spectral parameter map overlain. Red = BD1900, green = BD2100, blue = SINDEX [5].*

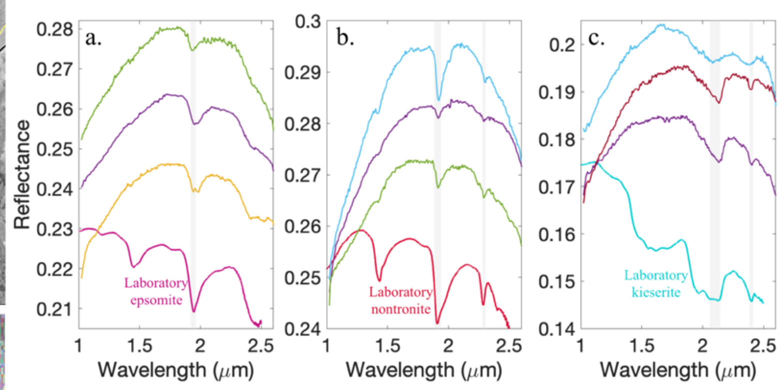

Fig. 4: *Example reflectance spectra (not ratioed, offset for clarity) from various points around Mt. Sharp showing relevant minerals compared to laboratory spectrum, with relevant absorption bands highlighted in gray.* ***(a.)*** *polyhydrated sulfate (1.95 µm highlighted),* ***(b.)*** *phyllosilicates (1.90 and 2.29 µm highlighted), and* ***(c.)*** *monohydrated sulfates (2.1 and 2.4 µm highlighted).*

Curiosity will approach these sulfate transitions during its extended mission, offering the opportunity to observe these mineralogical changes *in situ*. This will allow for placing these transitions in a clear geologic context, which in turn can be used to test possible formation hypotheses and lend insight into the lateral and temporal evolution of the climate and fluid history in Gale crater during and/or after its lacustrine period.

References: [1] Grotzinger J. P. et al. (2014). *Science*, 343. [2] Milliken R. E., Grotzinger J. P., and Thompson B. J. (2010). *GRL*, 37, L04201. [3] Itoh Y. and Parente M. (2017). IEEE International Geo. and Rem. Sensing Symposium. [4] Itoh Y. and Parente M. (2019) *LPSC 50,* Abstract #2025. [5] Viviano-Beck C. E. et al. (2014) *JGR: Planets*, 119, 1403-1431. [6] Milliken, R.E. (2011), 5th MSL Landing Site Workshop, Monrovia, CA, https://marsoweb.nas.nasa.gov/ landingsites/msl/workshops/5th_workshop/program.html. [7] Fraeman A. A. et al. (2016). *JGR: Planets*, 121, 1713-1736. [8] Golombek M. et al. (2012). *Space Sci. Rev.* 170:641-737.